California Energy Commission
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HPCBS

High Performance Commercial Building Systems

Data Logging Guide for TAC Americas Energy Management and Control Systems

Element 5 - Integrated Commissioning and Diagnostics
Project 2.2 - Monitoring and Commissioning of Existing Buildings
Task 2.3.1 - Develop a guide to implementation of monitoring systems in existing buildings

Charles Culp
Energy Systems Laboratory, Texas A&M University
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Data Logging Guide

for

TAC – Americas

Energy Management and Control Systems

Submitted By

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Table of Contents

Executive Summary

This Guide presents detailed procedures to determine the monitoring capability of an existing EMCS (Energy Management Control System) and perform any upgrades to the EMCS to enable data logging. This Guide outlines application procedures to enable an existing EMCS to measure the hourly energy consumption of a building or facility. The parameters to monitor include electrical consumption, thermal consumption (flow and temperatures), room temperature and other physical parameters.

This Guide enables the user to understand and verify how the existing controller can be configured to monitor the above parameters. Briefly, this includes:

- Determining the functionality of the existing EMCS controller models and software versions.
- Upgrading the physical monitoring capability of the existing controller, if needed.
- Selecting the correct sensors for the application in existing EMCS controllers.
- Following procedures to set up and configure the EMCS to log the desired data.

Once these procedures are fully implemented, the existing EMCS can be effectively used as a data logger. This results in a very cost effective method to acquire data logger quality data in an existing EMCS.

CHAPTER 1. INTRODUCTION

This Guide covers products designed by TAC-Americas (previously CSI, Control Systems International), introduced since 1994. A complete list of TAC-Americas software and hardware products that have been installed since 1994 are covered in this Guide. Improvements and introduction dates to the products are also covered. This Guide presents detailed procedures to determine the monitoring capability of a TAC-Americas existing EMCS (Energy Management Control System) and perform any needed upgrades to the EMCS to enable data logging.

Chapter 2 covers how to determine the functionality of the existing EMCS controller and software versions. Also covered is how to determine if upgrades are needed to the existing system. After implementing the steps in Chapter 2, the base system will be ready to be configured and used as a data logger.

Chapter 3 then covers specifically how to set-up and configure the EMCS as a data logger. Procedures are provided to enable selected data logger monitoring functions. These include electrical consumption, thermal flow and room monitoring. Data collection and storage requirements are also provided.

The Appendices covers programming details and accuracy determinations. A specific electrical consumption accumulation program, a thermal consumption calculation program and an extended log archiving program are provided. An example of temperature accuracy is provided so that the user can better determine the accuracy of thermal measurements.

This Guide enables the user to understand and verify that the existing controller can be configured to monitor the above parameters. Briefly, this includes:

- Determining the existing EMCS controller models and software versions.
  - Table 1 in Chapter 2 lists TAC-Americas' controllers and software versions. If the existing controller models and software versions found in the facility are listed in Table 1, this Guide can be used to upgrade the EMCS to store historical data of the parameters needed to determine the hourly energy consumption in a facility.

- Upgrading the physical monitoring capability of the existing controller, if needed.
  - Chapter 2 contains guidance on what will need to be upgraded, based on the existing EMCS models and software.
- Selecting the correct sensors for the application in existing EMCS controllers.
  - Chapter 3 provides information about what input types different controllers can accept and provides accuracy of the sensors. Guidance in selecting the correct sensor type is provided.
- Following procedures to set up and configure the EMCS to log the desired data.
  - Chapter 3 provides procedures to configure the EMCS to log data for specific applications. The applications include electrical consumption and demand monitoring using a Watt-Hour transducer, electrical consumption and demand monitoring using a Watt transducer, thermal monitoring using a Btu meter or EMCS, monitoring room temperature and data collection and storage guidance.

CHAPTER 2. DETERMINE EXISTING SYSTEM FUNCTIONALITY

STEP 1: Check the software version and the existing controller model of the controller connected to the sensor that will be used.

STEP 2: Verify the firmware release and hardware/software compatibility.

STEP 3: Find the general specification of the controller and the input type for each controller.

STEP 4: Check data logging performance of controller.

STEP 5: Upgrade EMCS for data logging.

Details of each step follow.

Step 1: Check the software version and the existing controller model of the controller connected to the sensor that will be used.

If the controller model is listed in Table 1, this Guide can provide a guideline of how to setup and store the history data. If the existing controller model is not included, consult with TAC-Americas to possibly use the existing controller or upgrade it to a current model. If I/NET 7700 is still used, a software upgrade to I/NET 2000 is recommended to eliminate any Y2K problems.

Table 1. TAC-Americas Hardware and Software Products

Hardware	
Name	Model Number
Distributed Control Unit	7700 DCU
	7740 DCU
Process Control Unit	7716 PCU
	7718 PCU
	7756 PCU
I/SITE I/O	7728 I/SITE I/O
Unitary Controller	7251 UC
	7270 UC
Micro Regulators	MR 123
	MR 55
	MR 88
	MR 632
	MR 160
	MR 88R
Software	
I/NET 2000	
I/NET 7700	

I/NET systems have the 7700 family of controllers (called DCU: Distributed Control Unit) as monitor and control instruments. Various sensors, actuators, transducers, signal converters and relay boards can be connected to these controllers to measure thermal and electrical properties and control HVAC equipment and lighting. All DCUs / controllers are located on the Controller LANs or the Controller subLANs. Several DCUs / controllers can operate on a single Controller LAN and share the sensor data, the internal calculations, and other information from one DCU / controller with other controllers. There are many different types of controllers under the 7700 family listed in Table 1 that can be configured with a variety of input and output (I/O) types.

- <u>7700 Distributed Control Unit (7700 DCU)</u>: This is the controller used in most I/NET systems. It communicates on the Controller LAN and provides automatic control and information about building operation.
- <u>7740 Distributed Control Unit (7740 DCU)</u>: This controller provides the same function and the basic I/O point capabilities as the 7700 DCU controllers. This controller does not allow any point expansion.
- <u>7716 Process Control Unit (7716 PCU)</u>: The 7716 provides the same functional capabilities as the 7700 controllers with reduced I/O point count and cost. It communicates on the Controller LAN and has the ability to connect directly to a host workstation without using a Tap. The expansion card, which adds input and output points, can extend the 7716 PCU controller I/O capabilities.
- <u>7718 Process Control Unit (7718 PCU)</u>: This controller is primarily designed for European distribution but sold in all markets. It contains similar functions as 7716 PCU controllers.
- <u>7756 Process Control Unit (7756 PCU)</u>: The 7756 PCU controller is a combination of a high-speed, fully distributed microprocessor-based motherboard (with 8 universal input points) and a high-resolution I/O board (with 24 universal input points).
- <u>7728 I/SITE I/O</u>: The 7728 controller is a satellite controller with a built-in display screen to support local operation without a local workstation. It contains similar functions as 7716 and 7718 controllers.
- <u>Unitary Controllers</u>: These controllers communicate on a Controller sub LAN and have a 7760 Unitary Controller interface as a gateway to communicate to the Controller LAN. There are several models of Unitary Controllers, 7210/7211, 7251, 7260 and 7270; however, the only two models recommended for monitoring are the 7251 UC and the 7270 UC.

- Micro Regulators: These controllers communicate on a Controller sub LAN and have a 7792 Micro Regulator Interface as a gateway to communicate to the Controller LAN. There are many models of Micro Regulator Controllers, MR 55, MR123, MR88, MR632, MR 160 and MR88R.

I/NET has two versions of software, I/NET 7700 and I/NET 2000. I/NET 7700 is the earlier EMCS software. It runs in a DOS environment and controls and monitors HVAC, lighting and other environmental systems. This software also allows the operator collect operating or environmental data, generate reports and include a graphic package that can provide a dynamic, animated display in color. For monitoring purposes, the I/NET 7700 feature of interest is Docutrend. Docutrend is a multi-purpose data collection and custom reporting utility that will be used extensively for monitoring purposes. The procedure of how to set-up Docutrend to collect and store data will be shown later in this Guide (see Chapter 3, Application F). I/NET 2000 is the upgraded version of I/NET 7700 that is running on Windows 95, 98 and NT 4.0. Most features, especially Docutrend, still work the same way. For more information, please contact TAC-Americas representatives.

Step 2: Verify the firmware release and hardware/software compatibility.

Knowing the year of EMCS installation, the firmware release and hardware/software compatibility can be found in Table 2. This table provides a revision time frame of each product launched since 1994. The first two columns from the time column are software revision time frames. The remaining columns are the hardware time frames, as listed in Table 1. In each column, the double line represents the starting time of the product (beginning with January 1994) and the single line represents the starting time of the new revision of that product. This table also shows the compatibility between hardware and software by using colors as follows.

Represents I/NET 7700 and its compatible system

Represents I/NET 2000 and its compatible system

Represents I/NET 7700 and I/NET 2000 Software compatible

Represents the starting year of system which is compatible to both I/NET 7700 and I/NET 2000 Software

Table 2. TAC-Americas Product Revision History

	INET7700	INET2000	7200 UC	7700 DCU	7756 PCU (Async)	7756 PCU (Sync)	7716 PCU (Async)	7716 PCU (Sync)	7718 PCU (Async)	7718 PCU (Sync)	7728 I/SITE I/O (Async)	7728 I/SITE I/O (Sync)	7740 DCU	MR123-032MB/632	MR123-210/430/400MB	MR160	MR55X	MR88
1/94	3.06		3.07	3.03				3.04		2.04			3.03	1.02	1.03			
2/94			3.08															
3/94	3.07			3.04				3.05		2.05			3.04	1.03	1.04			
4/94																		
5/94																		
6/94																		
7/94	3.10		3.09	3.10				3.10		2.10		1.00	3.10		1.10	1.00	1.00	
8/94	3.11											1.01		1.10	1.11	1.01		1.00
9/94	3.12														1.12			
10/94				3.11				3.11		2.11			3.11					
11/94	3.13																	
12/94																		
1/95																		
2/95						1.00		3.12						1.11				
3/95										2.12		1.02				1.02	1.01	1.01
4/95																		
5/95																		
6/95																		
7/95																		
8/95																		
9/95	3.14			3.12		1.01								1.12	1.13	1.03	1.02	1.02
10/95						1.02												
11/95																		
12/95	3.15							3.13		2.13		1.03	3.12					
1/96																		
2/96																		
3/96	3.16																	
4/96	4.00																	
5/96	4.01																	
6/96																		
7/96	4.02																	
8/96																		
9/96	4.03			3.13				3.14		2.14				1.13	1.14		1.03	1.03
10/96						1.03						1.04	3.13			1.04		
11/96																		
12/96	4.10																	
1/97																		
2/97																		
3/97																		
4/97																		
5/97	4.20																	
6/97																		
7/97						1.04		3.15		2.15			3.14					
8/97	4.21																	
9/97												1.05						
10/97																		

Table 2. TAC-Americas Product Revision History (continued)

	INET7700	INET2000	7200 UC	7700 DCU	7756 PCU (Async)	7756 PCU (Sync)	7716 PCU (Async)	7716 PCU (Sync)	7718 PCU (Async)	7718 PCU (Sync)	7728 I/SITE I/O (Async)	7728 I/SITE I/O (Sync)	7740 DCU	MR123-032MB/632	MR123-210/430/400MB	MR160	MR55X	MR88
11/97																		
12/97																		
1/98																		
2/98																		
3/98	4.30																	
4/98																		
5/98						1.05												
6/98				3.20									3.20					
7/98																		
8/98																		
9/98																		
10/98																		
11/98																		
12/98		1.00																
1/99		1.01																
2/99		1.10												1.13				
3/99		1.10a						3.20		2.20		1.10				1.04	1.03	
4/99	4.31																	
5/99		1.11																
6/99																		
7/99																		
8/99																		
9/99			3.09		2.00	1.10	4.00		3.00		2.00				1.14			1.03
10/99				3.21									3.21					
11/99		1.12																
12/99																		
1/00																		
2/00																		
3/00																		
4/00																		
5/00		1.13																
6/00																		
7/00																		
8/00		2.00																
9/00																		
10/00		2.10																
11/00									3.01	2.21			3.22					
12/00					2.10	1.20	4.01	3.21			2.10	1.20						
1/01				3.30										1.14		1.05	1.04	
2/01		2.11																
3/01																		
4/01									3.10	2.30								
5/01		2.12											3.30					
6/01		2.20			2.11	1.21	4.11	3.31	3.11	2.31	2.11	1.21						
8/01		2.21																

Step 3: Use Table 3 to find the general specification of the controller and the input type for each controller.

The four input types included for analog inputs are current, voltage, thermistor and platinum RTD. The digital input type requires the input to have a counter or accumulative feature. For example, if the 7700 DCU is going to be used to monitor room temperature, we can conclude from Table 3 that only a current or voltage-type temperature sensor can be used with this controller. This will help with selecting the correct sensor.

Table 3. TAC-Americas Hardware Specification

Model	Analog Input				Digital Input	
	Current	**Voltage**	**Thermistor**	**Platinum RTD**	**Digital**	**Counter**
7200 UC	N/A	N/A	N/A	N/A	contact closure	N/A
7700 DCU	4-20 mA ACCURACY 0.5 %	1-5 V DC ACCURACY 0.1 %	N/A	N/A	Optically isolated voltage input FREQ.: 4 Hz (max) PULSE WIDTH: 50 ms (min)	
7716 PCU	0-20 mA ACCURACY 0.5 %	0-5V, 0-10V ACCURACY 0.1 %, 2 %	N/A	N/A	5V @ 5 mA FREQ.: 4 Hz (max) PULSE WIDTH: 120 ms (min)	
7718 PCU	0-20 mA ACCURACY 0.5 %	0-5V, 0-10V ACCURACY 0.1 %, 2 %	N/A	N/A	5V @ 5 mA FREQ.: 4 Hz / 20 Hz PULSE WIDTH: 120 ms (min)	
7728 I/SITE I/O	0-20 mA ACCURACY 0.5 %	0-5V, 0-10V ACCURACY 0.1 %, 2 %	10K Ω ACCURACY 5 % [Typ. 2 %]	N/A	5V @ 5 mA FREQ.: 4 Hz / 20 Hz PULSE WIDTH: 55 ms (min)	
7740 DCU	0-20 mA ACCURACY 0.5 %	0-5 V ACCURACY 0.1 %	N/A	N/A	Dry contact FREQ.: 4 Hz (max) PULSE WIDTH: 120 ms (min)	

Table 3. TAC-Americas Hardware Specification (continued)

<table>
<tr><th rowspan="2">Model</th><th colspan="4">Analog Input</th><th colspan="2">Digital Input</th></tr>
<tr><th>Current</th><th>Voltage</th><th>Thermistor</th><th>Platinum RTD</th><th>Digital</th><th>Counter</th></tr>
<tr><td>7756 PCU
Upper motherboard

Lower motherboard</td><td>0-20 mA
ACCURACY
0.4%
0-40 mA
ACCURACY
0.12%</td><td>0-5 V
ACCURACY
0.1%
0-10 V
ACCURACY
0.02%</td><td>N/A</td><td>N/A</td><td colspan="2">5V @ 5 mA
FREQ.: 4 Hz (max)
PULSE WIDTH: 120 ms (min)
5V @ 5 mA
FREQ.: 20 Hz (max)
PULSE WIDTH: 25 ms (min)</td></tr>
<tr><td>MR 55</td><td>N/A</td><td>N/A</td><td>10K Ω
ACCURACY 2 %</td><td>N/A</td><td colspan="2">5V @ 0.5 mA
PULSE WIDTH: 1 ms (min)</td></tr>
<tr><td>MR 123</td><td>N/A</td><td>0-10 V
ACCURACY
2 %</td><td>10K Ω
ACCURACY 2 %</td><td>N/A</td><td colspan="2">5V @ 5 mA
FREQ.: 9 Hz (max)
PULSE WIDTH: 55 ms (min)</td></tr>
<tr><td>MR 88
MR 88R
MR 160
MR 632</td><td>0-20 mA
ACCURACY
2 %</td><td>0-5V,0-10V
ACCURACY
1%, 2%</td><td>10 K Ω
ACCURACY 2 %</td><td>N/A</td><td colspan="2">5V @ 5 mA
FREQ.: 4 Hz (max)
PULSE WIDTH: 100 ms (min)</td></tr>
</table>

Step 4: Check data logging performance of controller.

Knowing the existing controller, use Table 4 to check for acceptable data logging performance of the controller for each monitoring parameter: electrical consumption, thermal consumption and room temperature. Table 4 provides recommendations in the event the existing controller cannot be used to monitor a parameter.

Table 4. TAC-Americas Hardware and Monitoring Capabilities Compatibility

	Electrical Consumption		**Thermal Consumption**		**Room Temperature**
Sensor Device Output	Digital	Analog	Digital	Analog	Analog
7200 UC	X^1	X^1	X^1	X^1	•
7700 DCU	•	•	•	•	•
7716 PCU	•	•	•	•	•
7718 PCU	•	•	•	•	•
7728 I/SITE I/O	•	•	•	•	•
7740 DCU	•	•	•	•	•
7756 PCU	•	•	•	•	•
MR 55	X^2	X^2	X^2	X^1	•
MR 123	•	X^2	•	X^1	•
MR 88, 88R, 160, 632	•	•	•	X^1	•

- Indicates acceptable performance for logging a point type:

X^1 Replace this device with a PCU 7716

X^2 Replace this device with a MR88

Note that the 7200 UC (Unitary Controller) only accepts a special temperature sensor type. Therefore, it cannot be used to monitor other parameters. The MR 55 (Micro Regulator) cannot be used for BTU calculation because of the input slot limitation and low accuracy.

Step 5: Upgrade EMCS for data logging

After establishing the compatibility and type of parameter to be monitored and logged, and knowing which type of meter or calculation to use, a set of upgrade procedures can be selected. The following application upgrade procedures are outlined in Chapter 3:

- Electrical Consumption and Demand Monitoring Using Watt Hour Transducer (digital input)
- Electrical Consumption and Demand Monitoring Using Watt Transducer (analog input)
- Thermal Consumption Monitoring Using BTU Meter
- Thermal Consumption Monitoring Using EMCS
- Room Temperature Monitoring

CHAPTER 3. APPLICATION SET-UP PROCEDURES

The following tables provide the requirements to enable the existing controllers to perform the specified functions.

Application A. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer.

Application B. Electrical Consumption Monitoring Using A Watt Transducer.

Application C. Thermal Consumption Monitoring Using BTU Meter.

Application D. Thermal Consumption Monitoring Using EMCS.

Application E. Room Temperature Monitoring.

Application F. Configure For Data Collection And Storage In I/NET 2000.

Application A. Electrical Consumption and Demand Monitoring Using a Watt Hour Transducer

Charts A-1 through A-4 will provide the user with steps to set up a Watt Hour Transducer to monitor electrical consumption and demand. By following these steps, the user will enable the EMCS to measure electrical consumption (kWh) and store fifteen-minute data. Chart A-1 lists the needed equipment and helps the user determine whether the controller has an available input slot. Chart A-2 aides the user in choosing a Watt Hour Transducer (WHT) and a Current Transducer (CT). The chart lists the accuracy, pulse widths and pulse rates the WHT and CT require for each controller model. The chart also lists wire and sensor specifications. Tips for CT installation are provided as well. Chart A-3 provides an example of a WHT and a CT available in the market. Chart A-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly consumption, display current demand and record 15-minute demand. The user should then proceed to Application F to set up the data collection and history data storage.

STEP 1. Check the input slot availability on the controller.

> Use Chart A-1 to find which slots are needed on the controller. The position of the slot can be found in Chart A-1 under Controller Terminal Connections. For example, the 7756 PCU needs an available slot on one of its six terminal blocks,TB1-x, TB1A-x, TB1B-x, TB2-x, TB2A-x or TB2B-x. The lower case "x" represents the terminal position in that terminal block and is denoted by 1, 4, 7 or 10. If slots are available on any of these, the procedure can be followed. If there are no available slots please contact a TAC-Americas representative to determine whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

STEP 2. Choose a Watt Hour Transducer (WHT) and Current Transducer (CT).

Chart A-2 lists the WHT and CT specifications. For example, an acceptable Watt Hour Transducer for 7756 PCU should have discrete output with ± 0.5% accuracy or better and at least 120 ms pulse width at 4 Hz maximum pulse rate (for the upper mother board input) or at least 25 ms pulse width at 20 Hz maximum pulse rate (for the lower I/O board). With matching CT output and accuracy selection of 1% or better, the end-to-end accuracy from the transducers to the 7756 PCU controller could be around ± 1.5%. Note that to gain this accuracy the transducers must be placed no further than 200 ft. away with 22 AWG type wire.

Chart A-3 shows an example of a WHT and a CT provided in the market.

STEP 3. Follow the EMCS programming steps.

Chart A-4 provides the steps to set up the external input point from the transducer and the internal points to store the consumption value the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

STEP 4. Follow the steps in Application F.

Application F lists the steps to set up the data collection and history data storage.
After following the above steps, the system can collect monthly consumption, display current demand, and record 15-minute demand.

Chart A-1. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below. In addition, the terminal connections on the controller need to have the resistors connected as specified below.

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
What is measured	• Electrical consumption of either One-Phase or Three Phase, 208 to 480 V ac rms, 50/60 Hz							
What is stored in EMCS	• Fifteen-minute data of electric consumption in kWh units stored in Trend Data History.							
What is needed	3 - CT sensor 1 - Watt Hour Transducer 1 – available slot on Terminal Block (for external discrete input) 2 – available internal points 1 – available internal analog output point (to display current demand) 1 – available internal pulse input point (to accumulate month-to-date consumption)							
Controller Terminal Connections	TB1-x, TB1A-x, TB1B-x, TB2-x, TB2A-x or TB2B-x where x can be 1,4, 7 or 10	TB3 – x where x is 1-8	TB1 or TB2	TB1 or TB2	TB1, TB2 or TB3	TB5 – x where x is 1, 3, 5, …, 15	TB4 – x where x is 3-5	TB5 or TB6 for MR 160 TB4 for others
Resistor in Terminal Connections	A 1KΩ, 1/8 W, 1% resistor in "B" position (and "D" position for 20 Hz)	None	A 1KΩ, ¼ W, 5% resistor in "B" position	A 1KΩ, ¼ W, 5% resistor in "B" position	A 1KΩ, ¼ W, 5% resistor in "B" position	None	None	A 1KΩ, 1/8 W, 1% resistor in "B" position

Chart A-2. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

Watt Hour Transducer and Current Transducer Specifications

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
Output Type from Watt Hour Transducer	Discrete (each pulse is equal to xxx kWh, varies with specific sensor)							
Maximum Pulse Rate	4 Hz for upper motherboard/ 20 Hz for lower I/O board	4 Hz	4 Hz	4 / 20 Hz	4 / 20 Hz	4 Hz	9 Hz	4 Hz
Minimum Pulse Width	120 ms for upper motherboard / 25 ms for lower I/O board	50 ms	120 ms	120 ms	55 ms	120 ms	55 ms	100 ms
Accuracy from Watt Hour Transducer	±0.5 % (not including CT's)							
Maximum Wire Length (ft.)	200 ft. @ 22 AWG (guideline from manufacturer)							
CT Accuracy	± 1.0 %							
Note	CT sensors Output: Match the input type for Watt Hour Transducer Input: Make sure that input current is enough to cover the normal current							
End-to-end Accuracy	± 1.5 %							

Next, the specifications for the Watt Hour Transducer must satisfy the input requirements for the controller.

Make sure that the device will cover the peak demand kW, not generate more pulses than the maximum pulse rate and maintain the signal pulse width at least for the minimum pulse width duration. Current Transformers (CT's) have several styles. Split core CTs are easier to install. Make sure that these are installed in the correct direction. Checking the polarity of the current read by the EMCS can do this.

Notes on installation:

- Install CT sensors on the electrical main panel. Follow the manufacturer's instructions.
- Install Watt Hour Transducer and terminate CT sensor outputs at the WHT inputs. Follow the manufacturer's instructions.
- Electrical shock can occur from CT's without a shunt resistor.
- Terminate Watt Hour Transducer output at the Terminal Block. Follow the manufacturer's instructions.

Chart A-3. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

An Example of Watt Hour Transducer Specifications

The following Watt-Hour Transducer has been successfully used.

Watt Hour Transducer		
Ohio Semitronics, Inc.		
WL-3968		
Input	Current	Output from Current Transformer 0 - 0.333 V
	Voltage	120/208 & 277/480
	Phase	Three-Phase, Three-Wire or Three-Phase, Four-Wire
	Range	±15%
	Burden	None
	Power Factor	0.5 Lead to 0.5 Lag
	Instrument Power	208/240/480, 50/60 Hz, 2.5 Watts
Output	Relay	Dry Contact, 120 V, 0.3 A, 10 VA Max
	Closure Duration	250 Milliseconds
	Accuracy	± 0.5% F.S.
	Isolation	Input/Output/Case 750 Vac
	Temperature Effects	(-20°C to +60°C) +/- 0.02%/°C

Chart A-3. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer (continued)

An Example of Current Transducer Specifications

The following Current Transducer has been successfully used.

<table>
<tr><th colspan="3">Current Transducer</th></tr>
<tr><th colspan="3">Sentran Corporation</th></tr>
<tr><th colspan="3">4LS3 Split Bus Bar</th></tr>
<tr><td rowspan="3">Input</td><td>Current</td><td>AC current, sinewave, single phase 60 Hz, Load PF 0.5-1 lead or lag
100, 200, 300, 400, 500, 600, 800, 1K, 1.5K, 2K, 2.5K and 3K Amp</td></tr>
<tr><td>Voltage rating</td><td>600 V ac Tested Per ANSI C57.13 BIL 10 KV AC Full Wave for 60 seconds</td></tr>
<tr><td>Bandwidth</td><td>10 Hz to 1000 Hz +/- 3 db</td></tr>
<tr><td rowspan="7">Output</td><td>Voltage</td><td>100 mV, 250 mV, 333 mV, 500 mV, 1 V and 5 V</td></tr>
<tr><td>Limiting</td><td>20 V AC RMS</td></tr>
<tr><td>Accuracy</td><td>± 1% ratio and linearity accuracy from 5% to 200% of scale</td></tr>
<tr><td>Phase Displacement</td><td>± 1 degree</td></tr>
<tr><td>Output Resistance</td><td>< 100 Ohms</td></tr>
<tr><td>Interface Resistance</td><td>> 10K Ohms</td></tr>
<tr><td>Lead Wires</td><td>20 or 22 AWG UL1015, 600V insulation, 105 C</td></tr>
</table>

Chart A-4. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

EMCS Programming Steps

Summary

1. Set up an external pulse input (PI) point in EMCS to accumulate daily consumption for the Wh-to-pulse transducer.
2. Set up an internal pulse input (PI) point to accumulate monthly consumption from the external point created in Step 1.
3. Set up an internal analog output (AO) point in EMCS to display current demand from the external point created in Step 1.
4. Create a Demand Control point extension on external PI point created in Step 1.
5. Create a Trend point extension on the internal analog output point in EMCS allowing the EMCS to record demand values every fifteen minutes.

Step 1. Set up an external pulse input (PI) point in EMCS to accumulate daily consumption for Wh-to-pulse transducer.

In I/NET 2000, perform the following steps:

a. Connect installed sensors to the controller.

b. Select “Edit”, then “Controller”, then “Resident I/O Points”.

c. Click “Add” and New Resident Point editor will be displayed. Set the following parameters as specified below:

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R,160, 632
Input Type	PI							
Input Address	See Appendix A	280x x is pin # -1 Ex: TB3-1 has the address of 2800 Point: 28 Bit Offset: 00	0000-0007	0000-0007	0000-0007 and 0100-0103	280x x is (pin #-1)/2 Ex: TB5-11 has the address of 2805 Point: 28 Bit Offset:05	02-04	00-06 except for MR632 00-04
	Click “OK”							
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 kWh							
Scan Interval	1 second							
Point Class	External							
Global Level	Local (for not sharing the point information with other controllers)							
Alarm Priority	None							
Message Priority	None							
Engineering Unit	Select a number that corresponds to the line number of “kWh”in Engineering Units Table							

Conversion Coefficient	Select a number that corresponds to the line number of "slope (m) = xxx and offset (b) = 0" in Conversion Coefficients Tables. If the correct slope and offset are not available, choose an empty pair (m=0, b=0) and enter the correct slope in the conversion coefficient editor (Edit -> Controller -> Station Parameters -> Conversion Coefficients)
Conversion Equation	Linear
Scan Between Broadcast	60 (broadcast value of this accumulator every 1 minute)
Accumulator Type	External 8 bit
	Click "OK"

Step 2. Set up an internal pulse input (PI) point to accumulate monthly consumption from the external point created in Step 1.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".
b. Click "Add" and then New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	PI
Output Address	Choose an unreserved internal address (See Appendix A for the list of hardware point addresses to be avoided)
	Click "OK"
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 Monthly kWh
Scan Interval	10 seconds
Point Class	Internal
Global Level	Local (for not sharing the point information with other controllers)

Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of “kWh”in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of “slope (m) = 1 and offset (b) = 0” in Conversion Coefficients Tables. If the correct slope and offset are not available, choose an empty pair (m=0, b=0) and enter the correct slope in the conversion coefficient editor (Edit -> Controller -> Station Parameters -> Conversion Coefficients)
Conversion Equation	Linear
Accumulator Type	Reflective
Scans Between Broadcasts	1
	Click “OK”

Step 3. Set up an internal analog output (AO) point in EMCS to display current demand from the external point created in Step 1.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.

b. Click “Add”, and New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	AO
Output Address	Choose an unreserved internal address (See Appendix A for the list of hardware point addresses to be avoided)
	Click “OK”
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 Current kW
Scan Interval	60 seconds
Point Class	Internal
Global Level	Local (for not sharing the point information with other controllers)

Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of “kW”in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of “slope (m) = 0.1 and offset (b) = 0” in Conversion Coefficients Tables. If the correct slope and offset are not available, choose an empty pair (m=0, b=0) and enter the correct slope in the conversion coefficient editor (Edit -> Controller -> Station Parameters -> Conversion Coefficients)
Offset	0
Low Output Limit	0
High Output Limit	6553.5
Broadcast Change Counts	1
	Click “OK”

Step 4. Create a Demand Control point extension on external PI point created in Step 1.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.
b. Click the “DC” box at the top of the window.
c. Locate the external PI point collecting pulses from the Wh-to-pulse transducer (BLDG1 kWh in this example) and click on the point address.
d. Click “Add” and Demand Control Extension Editor will be displayed. Set the following parameters as specified below.

Demand Interval	Determined by utility rate tariff, usually 15 minutes

Current Demand Point	Select name of internal AO point from pull-down (BLDG1 Current kW in this example)
Monthly Consumption Point	Select name of internal PI point from pull-down (BLDG1 Monthly kW in this example)
	Leave all other items at their default value and click "OK."

Step 5. Create a Trend point extension on the internal analog output point in EMCS. This will allow the EMCS to record demand values every fifteen minutes.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".
b. Click the "TR" box at the top of the window.
c. Locate the internal AO point displaying the current demand (BLDG1 Current kW in this example) and click on the point address.
d. Click "Add" and Trend Extension Editor will be displayed. Set the following parameters as specified below:

Sample Control Interval	15 minutes
Number of samples	1440 (will keep a fifteen-day rolling history of 15-minute demand readings in controller)
Sample control mode	None
	Leave all other items at their default value and click "OK."

Application B. Electrical Consumption Monitoring Using A Watt Transducer

Charts B-1 through B-4 provide the user with steps to set up a Watt Transducer to monitor electrical consumption and demand. By following these steps, the user will enable the EMCS to measure electrical consumption (kWh) and store fifteen-minute data. Chart B-1 lists the needed equipment and helps the user determine whether the controller has an available input slot. Chart B-2 aids the user in choosing a Watt Transducer (WT) and a Current Transducer (CT). The table lists the accuracy, output type and maximum length of wire the WT and CT require for the controller models. Chart B-3 provides an example of a WT and a CT available in the market. Chart B-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly consumption, display current demand and record 15-minute consumption. The user should then proceed to Application F to set up the data collection and history data storage.

STEP 1. Check the input slot availability on the controller.

Use Chart B-1 to find which slots are needed on the controller. The position of the slot can be found in Chart B-1 under Controller Terminal Connections. For example, 7700 DCU needs an available slot either on TB4-x or TB5-x. The lower case “x” represents the terminal positions, TB4 or TB5 terminal block, where “x” can be 1 to 8. If slots are available on either of these, the procedure can be followed. If there are no available slots please contact a TAC-Americas representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

STEP 2. Choose a Watt Transducer (WT) and Current Transducer (CT).

> Chart B-2 lists the WT and CT specifications. For example, an acceptable Watt Transducer for 7700 DCU should have analog output (preferred current 4-20 mA) with 0.5% accuracy or better. With matching CT output and accuracy selection of 1% or better, the end-to-end accuracy from the transducers to the 7700 controller could be around 2%. Note that to gain this accuracy the transducers must be placed no further than 200 ft. away with 22 AWG wire type. Chart B-3 shows an example of WT provided in the market. CT is included in this Watt Transducer example.

STEP 3. Follow the EMCS programming steps.

Chart B-4 provides the steps to set-up the external input point from the transducer and the internal points to store the consumption value the EMCS must recognize. Detailed steps provided in this chart must be followed to setup the external input point and internal points.

STEP 4. Follow the steps in Application F.

Application F lists the steps to set up the data collection and history data storage.
After the steps are complete, the system can be used to record monthly consumption and display current demand.

Chart B-1. Electrical Consumption Monitoring Using Watt Transducer

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below. In addition, the terminal connections on the controller need to have the resistors connected as specified below.

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
What is measured	Electrical consumption of either One-Phase or Three Phase, 208 to 480 V ac rms, 50/60 Hz							
What is stored in EMCS	Fifteen-minute data of electric consumption in kWh unit stored in Trend Data History.							
What is needed	3 - CT sensor 1 - Watt Transducer 1 – available slot on Terminal Block (for analog input) 1 – available internal accumulative points for electrical consumption							
Controller Terminal Connections	TB1-x, TB1A-x, TB1B-x, TB2-x, TB2A-x or TB2B-x where x can be 1,4, 7 or 10	TB4–x or TB5-x where x is 1-8	TB1 or TB2	TB1 or TB2	TB1, TB2 or TB3	TB6-x or TB7-x where x is 1, 3, 5, …, 15	Not Recommended Use MR88	TB4
Resistor in Terminal Connections	A 249Ω, 1/8W, 0.1% resistor in "A" position*	None	A 249Ω, 1/8 W, 0.1% resistor in "A" position	A 249Ω, 1/8 W, 0.1% resistor in "A" position	A 249Ω, 1/8 W, 0.1% resistor in "A" position	None		A 249Ω, 1/8 W, 0.1% resistor in "A" position

Chart B-2. Electrical Consumption Monitoring Using Watt Transducer

Watt Transducer and Current Transducer Specifications

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
Output Type from Watt Transducer	Analog, 4-20 mA							
Accuracy from Watt Transducer	±0.5 % (not including CT's)							
Maximum Wire Length (ft.)	200 ft. @ 22 AWG (guideline from manufacturer)							
CT Accuracy	± 1.0 %							
Note	CT sensors • Output: Match the input type for Watt Transducer • Input: Make sure that input current is enough to cover the normal current							
End-to-end Accuracy	Upper MB: ± 1.9 % Lower MB: ± 1.7 %	±2.0 %	±2.0 %	±2.0 %	±2.0 %	±2.0 %	Not Recommended Use MR 88	±3.5 %

Next, the specifications for the Watt Transducer must satisfy the input requirements for the controller. Make sure that the device will cover the peak demand kW. An example of the available Watt Transducer is shown in the next chart. The Current Transducer is already included in this example.

Chart B-3. Electrical Consumption Monitoring Using Watt Transducer

Example of Watt Transducer Specifications

Watt Transducer (CT included)		
Veris Industries, Inc.		
H-8040		
Input	Primary Voltage	208 or 480 V ac rms
	Phase	One-Phase or Three-Phase
	Primary Current	Up to 2400 amps cont. per phase
Output	Type	4 – 20 mA
	Supply Power	9 – 30 V dc; 30 mA max
	Accuracy	± 1%
	Internal Isolation	2000 V ac rms
	Case Insulation	600 V ac rms
	Current Transformer	Split core, 100, 300, 400, 800, 1600 or 2400 amps

Chart B-4. Electrical Consumption Monitoring Using Watt Transducer

EMCS Programming Steps

Summary

1. Set up an external analog input (AI) point in EMCS to accumulate daily consumption for the kW-to-pulse transducer.
2. Set up an internal accumulator point in EMCS.
3. Create a Trend point extension on the internal analog output point in EMCS.

This application will allow the EMCS to record 15-minute demand values.

Step 1. Set up an external analog input (AI) point in EMCS to accumulate daily consumption for the kW-to-pulse transducer.

In I/NET 2000, perform the following steps:

a. Connect the installed sensors to the controller.
b. Select "Edit", then "Controller", then "Resident I/O Points".

c. Click "Add", and New Resident Point editor will be displayed. Set the following parameters as specified below:

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R,160, 632
Input Type	AI							
Input Address	See Appendix A	TB4-x: 0X00 X = x –1 TB5-y: YY00 YY = y + 7 Ex: TB5-1 has the address of 0800 Point: 08 Bit Offset 00	0000-0007	0000-0007	0000-0007 and 0100-0103	TB6-x: 0X00 X = (x –1)/2 TB7-y: YY00 YY = 8 + (y-1)/2 Ex: TB7-1 has the address of 0800 Point: 08 Bit Offset 00	Not Recommended Use MR 88	00-06 except for MR632 00-04
	Click "OK"							
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 kW							
Scan Interval	1 second							
Point Class	External							
Global Level	Local (for not sharing the point information with other controllers)							
Alarm Priority	None							
Message Priority	None							
Engineering Unit	Select a number that corresponds to the line number of "KW" in Engineering Units Table							
Conversion Equation	Linear							
A/D Converter	Upper MB 12 bit Lower MB 16 bit	12 bit + 1 sign bit	12 bit	12 bit	12 bit	12 bit	Not Recommended Use MR88	8 bit

Conversion Coefficient	Use Pop-up Calculator to calculate for slope and offset
Pop-up Calculator	• Equipment Count Low: 0 (typical) • Equipment Count High: depend on controller A/D converter, 255 for 8-bit, 4,095 for 12-bit and 65,535 for 16-bit • Engineering Unit Low: The units being measured for the sensor when the device is at its low count value • Engineering Unit High: The units being measured for the sensor when the device is at its high count value
Offset	0 (default) or actual error divide by "slope (m)"to calibrate sensor, compensate for the long wire runs
Low Sensor Limit	The lowest number showing sensor is not in error, this number is the lowest kW
High Sensor Limit	The highest number showing sensor is not in error, this number is the highest kW
Low Alarm Limit	The lowest number before this point goes into alarm, 0 kW
High Alarm Limit	The highest number before this point goes into alarm, at least equal to High Sensor Limit
Broadcast Change Counts	Round-up number of 1% full scale kW demand divide by slope (m) For example: highest demand is 2000 kW, Broadcast Change Counts = 0.01*2000/m
Non-linear Lookup Table	0 (no lookup table)
	Click "OK"

Step 2. Set up an internal accumulator point in EMCS.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".

b. Click "Add", and New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	PI
Input Address	See Appendix A on point address summary, avoid using those hardware point addresses
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 KWHr
Point Class	Internal
Scan Interval	1 second
Global Level	Local (for not sharing the point information with other controllers)
Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of "KWh"in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of "slope (m) = 1 and offset (b) = 0" in Conversion Coefficients Tables
Conversion Equation	Linear
Accumulator Type	Integrating
Scans Between Broadcast	60 (broadcast value of this accumulator every 1 minute)
	Click "OK"
In Resident I/O Point window	• Add calculation in to the above PI point • In Equation Field, put "P0" • In Points, put point address of the kW demand AI point above, then click "OK"

<u>Step 3</u>. Create a Trend point extension on an internal accumulative point in EMCS. This will allow the EMCS to record 15-minute consumption values.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.
b. Click the “TR” box at the top of the window.
c. Locate the internal PI point displaying the current consumption (BLDG1 KWHr in this example) and click on the point address.
d. Click “Add”, and Trend Extension Editor will be displayed. Set the following parameters as specified below:

Sample Control Interval	15 minutes
Number of samples	1440 (will keep a fifteen-day rolling history of 15-minute demand readings in controller)
Sample control mode	None
	Leave all other items at their default value and click “OK.”

Application C. Thermal Consumption Monitoring Using BTU Meters

Charts C-1 through C-4 will provide the user with steps to set up a BTU meter to monitor thermal consumption. By following these steps, the user will enable the EMCS to measure thermal consumption (MMBtu) and store fifteen-minute data. Chart C-1 lists the needed equipment and helps the user determine whether the controller has an available input slot. Chart C-2 aids the user in choosing a BTU meter, temperature sensors and a flow meter. The chart lists the BTU meter, temperature sensor and flow meter accuracy for the controller models. The table also lists output type, pulse widths and pulse rates the BTU meter requires. Some tips for BTU meter selection and flow meter installation are provided as well. Chart C-3 provides an example of a BTU meter, a temperature sensor and a flow meter available in the market. Chart C-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly thermal consumption. The user should then proceed to Application F to set up the data collection and history data storage.

STEP 1. Check the input slot availability on the controller.

Use Chart C-1 to find which slots are needed on the controller. The position of the slot can be found in Chart C-1 under Controller Terminal Connections. For example, 7716 PCU requires an available slot on Terminal Block TB1 or TB2. If slots are available on either of these, the procedure can be followed. If there are no available slots please contact a TAC-Americas representative to determine whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

STEP 2. Choose a BTU Meter, Temperature Sensor and Flow Meter.

Chart C-2 lists the BTU meter, temperature sensor and flow meter specifications. For example, an acceptable BTU meter for 7716 PCU should have discrete output with at least 120 ms pulse width at 4 Hz maximum pulse rate. This BTU meter should be installed with matching temperature sensors and flow meter output at the recommended accuracy. The end-to-end accuracy of this thermal measurement does not only depend on the meter and sensors, but also the characteristics of the system (differential temperature). Chart C-2 and

Appendix B provide more information on this. Chart C-3 shows examples of a BTU meter, temperature sensors and a flow meter provided in the market.

STEP 3. Follow the EMCS programming steps.

Chart C-4 provides the steps to set up the external input point (from the BTU Meter) the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

STEP 4. Follow the steps in Application F.

Application F lists the steps to set up the data collection and history data storage.

After these steps are complete, the system can collect and store monthly thermal consumption data.

Chart C-1. Thermal Consumption Monitoring Using A BTU Meter

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below. In addition, the terminal connections on the controller need to have the resistors connected as specified below.

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
What is measured	• Chilled/Hot water flow • Chilled/Hot water supply and return temperature							
What is stored in EMCS	• Fifteen-minute data of Thermal Consumption in MMBtu units stored in Trend Data History							
What is needed	1 – Flow meter 2 – Temperature sensors 1 – BTU meter 1 – available slot on Terminal Block (for digital input)							
Controller Terminal Connections	TB1-x, TB1A-x, TB1B-x, TB2-x, TB2A-x or TB2B-x where x can be 1,4, 7 or 10	TB3 – x where x is 1-8	TB1 or TB2	TB1 or TB2	TB1, TB2 or TB3	TB5 – x where x is 1, 3, 5, …, 15	TB4 – x where x is 3-5	TB5 or TB6 for MR 160 TB4 for others
Resistor in Terminal Connections	A 1KΩ, 1/8 W, 1% resistor in “B” position (and “D” position for 20 Hz)	None	A 1KΩ, ¼ W, 5% resistor in “B” position	A 1KΩ, ¼ W, 5% resistor in “B” position	A 1KΩ, ¼ W, 5% resistor in “B” position	None	None	A 1KΩ, 1/8 W, 1% resistor in “B” position

Chart C-2. Thermal Consumption Monitoring Using a BTU Meter

BTU Meter, Flow Meter and Temperature Sensor Specifications

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
Output Type from BTU Meter	Digital Pulse (each pulse is equal to xxx MMBtu, varies with specific meter)							
Maximum Pulse Rate	4 / 20 Hz	4 Hz	4 Hz	4 / 20 Hz	4 / 20 Hz	4 Hz	9 Hz	4 Hz
Minimum Pulse Width	120 / 25 ms	50 ms	120 ms	120 ms	55 ms	120 ms	55 ms	100 ms
Accuracy from Flow Meter	Recommended Accuracy for flow meter is ± 1% full scale							
Accuracy from Temperature Sensor	Recommended Accuracy: ± 0.2 °F for chilled water temperature sensors and ± 0.5 °F for hot water temperature sensors							
End-to-end Accuracy	Depends on the accuracy of the temperature sensor, flow meter and how large the temperature difference is. Assuming the difference between chilled water supply and return temperature is 10 °F, the end-to-end accuracy can approach 5%. Assuming the difference between hot water supply and return temperature is 20 °F, the accuracy can approach 7%, without end-to-end calibration. See Appendix B							

Tips on BTU Meter selection:

- Ensure the BTU meter will cover the peak BTU, will maintain the output pulse signal with at least the minimum pulse width and not generate pulses in excess of the maximum pulse rate.
- Use matched temperature sensors.
- Temperature sensor and flow meter outputs are correct for the BTU meter inputs.
- The specifications for the BTU meters must satisfy the input requirements for the controller.

Notes on installation:

- Install the flow meter in the supply or return pipe.
- Install matched temperature sensors, one on the supply pipe and another on the return pipe.
- For the temperature sensor on the same pipe as the flow meter, install the sensor close to the flow meter.
- Disconnect the flow meter and temperature sensors at the BTU meter input board. Follow the manufacturer’s instructions.
- Disconnect the BTU meter output at the terminal block. Follow the manufacturer’s instructions.

Chart C-3. Thermal Consumption Monitoring Using a BTU Meter

An Example of BTU Meter, Flow Meter and Temperature Sensor Specifications

The following BTU meter, flow meter and temperature sensors have been used successfully.

BTU Measurement System, Keegan Electronics, Inc., System 90 Series		
Input	Temperature	2 matched temperature sensors supplied by Keegan Electronics
	Minimum Resolution of Temperature Reading	0.1°C
	Flow	1 flow sensor supplied by Data Industrial
	Minimum Closure Duration	2 milliseconds
	Maximum Length of cable	500 feet
	Electrical	Connect to high voltage (120 V AC) through a circuit breaker
Output	Standard Output	Monostable relay outputs, SPST, 2A @ 120 V AC resistive representing BTU's and Gallons
	Optional Output	0-1 mA DC or 4-20 mA DC representing instantaneous BTU/Hr and GPM
	Accuracy	Depends on the accuracy of temperature sensor, flow meter and how large the temperature difference is.

Temperature Sensor, Keegan Electronics, Inc., RTDs for System 90 Series		
Input	Temperature Range	0-100 °C
Output	Standard Output	RTD – variable resistance
	Reference	@ 0°C – output is equal to 32,654 ohms @ 100°C – output is equal to 679 ohms
	Accuracy	± 0.2 °C

Chart C-3. Thermal Consumption Monitoring Using a BTU Meter

An Example of BTU Meter, Flow Meter and Temperature Sensor Specifications

Flow Sensor, Data Industrial, 220 PVCS Insert Flow Sensor		
Input	Flow Rate	1 to 30 ft./sec
	Maximum Pressure	100 psi @ 68°F
	Maximum Temperature	140°F @ 40 psi
	Maximum Length of cable	20 feet shielded twisted pair AWG 20
Output	Standard Output	Voltage pulse, 5V or greater
	Accuracy	± 1% of Full Scale (over recommended design flow range)
	Absolute Accuracy	± 4% of reading within calibration range
	Linearity	± 1%
	Frequency	3.2 – 200 Hz
	Pulse Width	5 milliseconds ± 25%

Chart C-4. Thermal Consumption Monitoring Using a BTU Meter

EMCS Programming Steps

Summary

1. Set up an external pulse input (PI) point in EMCS to accumulate daily consumption for the BTU Meter.
2. Set up an internal pulse input (PI) point to accumulate monthly consumption from the external point created in Step 1.
3. Create a Trend point extension on the internal pulse input point in EMCS. This will allow the EMCS to record 15-minute consumption values.

The details of each step follows.

Step 1. Set up an external pulse input (PI) point in EMCS to accumulate daily consumption for BTU meter.

In I/NET 2000, perform the following steps:

a. Connect sensors that are installed to the controller.
b. Select "Edit", then "Controller", then "Resident I/O Points".
c. Click "Add" and New Resident Point editor will be displayed. Set the following parameters as specified below:

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R,160, 632
Input Type	PI							
Input Address	See Appendix A	280x x is pin # -1 Ex: TB3-1 has the address of 2800 Point: 28 Bit Offset: 00	0000-0007	0000-0007	0000-0007 and 0100-0103	280x x is (pin #-1)/2 Ex: TB5-11 has the address of 2805 Point: 28 Bit Offset: 05	02-04	00-06 except for MR632 00-04
	Click "OK"							
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 BTU							
Scan Interval	1 second							
Point Class	External							
Global Level	Local (for not sharing the point information with other controllers)							
Alarm Priority	None							
Message Priority	None							
Engineering Unit	Select a number that corresponds to the line number of "MMBTU" in Engineering Units Table							
Conversion Coefficient	Select a number that corresponds to the line number of "slope (m) = xxx and offset (b) = 0" in Conversion Coefficients Tables							
Conversion Equation	Linear							
Scan Between Broadcast	60 - (broadcast value of this accumulator every 1 minute)							
Accumulator Type	External 8 bit							
	Click "OK"							

Step 2. Set up an internal pulse input (PI) point to accumulate monthly consumption from the external point created in Step 1.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.
b. Click “Add”, and New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	PI
Output Address	Choose an unreserved internal address (See Appendix A for the list of hardware point addresses to be avoided)
	Click “OK”
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 Monthly MBtu
Scan Interval	10 seconds
Point Class	Internal
Global Level	Local (for not sharing the point information with other controllers)
Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of “MBtu”in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of “slope (m) = 1 and offset (b) = 0” in Conversion Coefficients Tables. If the correct slope and offset are not available, choose an empty pair (m=0, b=0) and enter the correct slope in the conversion coefficient editor (Edit -> Controller -> Station Parameters -> Conversion Coefficients)
Conversion Equation	Linear
Accumulator Type	Reflective
Scans Between Broadcasts	1
	Click “OK”

<u>Step 3</u>. Create a Trend point extension on internal pulse input point in EMCS. This will allow the EMCS to record 15-minute consumption values.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.
b. Click the “TR” box at the top of the window.
c. Locate the internal PI point displaying the current consumption (BLDG1 BTU in this example) and click on the point address.
d. Click “Add”, and Trend Extension Editor will be displayed.

Set the following parameters as specified below:

Sample Control Interval	15 minutes
Number of samples	1440 (will keep a fifteen-day rolling history of 15-minute demand readings in controller)
Sample control mode	None
	Leave all other items at their default value and click “OK.”

Application D. Thermal Consumption Monitoring Using an EMCS

Charts D-1 through D-4 will provide the user with steps to set up an EMCS to monitor thermal consumption. By following these steps, the user will enable the EMCS to measure thermal consumption (MMBtu) and store fifteen-minute data. Chart D-1 lists the needed equipment and will help the user determine whether the controller has an available input slot. Chart D-2 aids the user in choosing temperature sensors and a flow meter. The table lists the temperature sensor, flow meter accuracy and output type. Some tips for temperature sensor and flow meter installation are provided as well. Chart D-3 provides an example of a temperature sensor and a flow meter available in the market. Chart D-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly thermal consumption. The user should then proceed to Application F to set up the data collection and history data storage.

STEP 1. Check the input slot availability on the controller.

Use Chart D-1 to find which slots are needed on the controller. The position of the slot can be found in Chart D-1 under Controller Terminal Connections. For example, the 7740 DCU needs an available slot on Terminal Block TB6 or TB7. If slots are available on either of these, the procedure can be followed. If there are no available slots please contact a TAC-Americas representative to check whether an expansion I/O module can be added to this controller or if an additional controller must be installed.

STEP 2. Choose a Temperature Sensor and Flow Meter.

Chart D-2 lists the temperature sensor and flow meter specifications. For example, an acceptable temperature sensor and flow meter for the 7740 DCU should have analog output (current or voltage output). The end-to-end accuracy of this thermal measurement does not depend only on the meter and sensors but also the characteristics of the system (differential temperature). Chart D-2 and Appendix B provide more information on this. Chart D-3 shows an example of temperature sensors and a flow meter providing a BTU function.

STEP 3. Follow the EMCS programming steps.

Chart D-4 provides the steps to set up the external input point from the temperature sensor and flow meter, and internal points used to store the consumption that the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

STEP 4. Follow the steps in Application F.

Application F lists the steps to set up the data collection and history data storage.

After these steps are complete, the system can collect and store monthly thermal consumption data.

Chart D-1. Thermal Consumption Monitoring Using an EMCS

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below. In addition, the terminal connections on the controller need to have the resistors connected as specified below.

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
What is measured	• Chilled/Hot water flow • Chilled/Hot water supply and return temperature							
What is stored in EMCS	• Fifteen-minute data of Thermal Consumption in MMBtu unit stored in Trend Data History							
What is needed	1 – Flow meter 2 – Temperature sensors 3 – available slots on Terminal Block (for analog input from flow meter and temperature sensors) 2 – available internal points • 1 – available internal analog output point (to calculate for instantaneous thermal consumption) • 1 – available internal pulse input point (to accumulate month-to-date consumption)							
Terminal Block for Current and Voltage Analog Input	TB1-x or TB2-x For both current and voltage input (0-10 V) Or TB1A-x, TB1B-x TB2A-x, TB2B-x For current input where x can be 1, 4, 7 or 10	TB4–x or TB5-x	TB1 or TB2	TB1 or TB2	TB1, TB2 or TB3	TB6-x or TB7-x	Not Recommended Use PCU 7716 or BTU meter	

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
Resistor in Terminal Block for Current Input	A 249Ω, 1/8W, 0.1% resistor in “A” position	None	A 249Ω, 1/8 W, 0.1% resistor in “A” position			None	Not Recommended Use PCU 7716 or BTU meter	
Resistor in Terminal Block for Voltage Input	A 100KΩ, 1/8 W, 1% resistor in “C” position	None	A 100KΩ, 1/8 W, 1% resistor in “C” position			None	Not Recommended Use PCU 7716 or BTU meter	

Chart D-2. Thermal Consumption Monitoring Using an EMCS

Flow Meter and Temperature Sensor Specifications

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
Output Type from Flow Meter	Analog, either voltage or current output							
Output Type from Temperature Sensors	Analog, current output							
Maximum Wire Length (ft.)	200 ft. @ 22 AWG (guideline from manufacturer)							
End-to-end Accuracy	End-to-end accuracy depends on the accuracy of temperature sensor, flow meter and how large the temperature difference is. Assuming the difference between chilled water supply and return temperature is 10 °F, the end-to-end accuracy can approach 5%. Assuming the difference between hot water supply and return temperature is 20 °F, the accuracy can approach 7%, without end-to-end calibration. See Appendix B							
Note	Recommended accuracy for temperature sensor: ± 0.2 °F of full scale for chilled water temperature sensors and ± 0.5 °F of full scale for hot water temperature sensor Recommended accuracy for flow meter: ± 1% of full scale Temperature sensors should be matched							

Notes on installation:

- Install the flow meter in either the supply or return pipe.
- Install matched temperature sensors, one on the supply pipe and another on the return pipe.
- For the temperature sensor on the same pipe as the flow meter, install the sensor close to the flow meter.
- Disconnect the flow meter and temperature sensors at the Terminal Blocks. Follow the manufacturer’s instructions.

Chart D-3. Thermal Consumption Monitoring Using an EMCS

An Example of Flow Meter and Temperature Sensor Specifications

The following flow meter and temperature sensors have been used successfully.

Temperature Sensor, Minco Products, Inc, RTD with TempTran transmitter		
Input	Temperature Range	30-80 °F (for chilled water system)
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.2 % of span

Flow Meter and Transmitter, Rosemount, 8705 with the integral mounted type transmitter model 8732		
Input	Flow Rate	0.04 to 30 ft./sec
	Maximum Pressure	285 psi @ 100°F
	Temperature Condition	Natural Rubber Lining: 0 to 185 °F
	Minimum Liquid Conductivity	5 microsiemens/cm
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.5% of rate from 1 to 30 ft/sec and ± 0.005 ft/sec from 0.04 to ft/sec

Chart D-4. Thermal Consumption Monitoring Using an EMCS

EMCS Programming Steps

Summary

1. Set up external analog input points in the EMCS for the flow meter and temperature sensors.
2. Set up internal analog output points in the EMCS for temperature conversion from °F to °C.
3. Create a Trend point extension on the first point set-up in Step 2 to convert the temperature unit from °F to °C.
4. Set up an internal pulse input point in the EMCS for month-to-date thermal consumption.
5. Create a Trend point extension on the second point set-up in Step 4 to calculate the instantaneous thermal consumption.
6. Create a Trend point extension on the internal analog output point in EMC to record 15-minute consumption values.

Details of these steps follow.

<u>Step 1</u>. Set-up external analog input points in the EMCS for the flow meter and temperature sensors

In I/NET 2000, perform the following steps:

a. Connect installed sensors to the controller.

b. Select “Edit”, then “Controller”, then “Resident I/O Points”.

c. Click “Add” and New Resident Point editor will be displayed. Set the following parameters as specified below:

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R,160, 632
Input Type	AI							
Input Address	See Appendix A	TB4-x: 0X00 X = x –1 TB5-y: YY00 YY = y + 7 Ex: TB5-1 has the address of 0800 Point: 08 Bit Offset 00	0000-0007	0000-0007	0000-0007 and 0100-0103	TB6-x: 0X00 X = (x –1)/2 TB7-y: YY00 YY = 8 + (y-1)/2 Ex: TB7-1 has the address of 0800 Point: 08 Bit Offset 00	Not Recommended Use PCU 7716	
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 Tchws for Building1 chilled water supply temperature							
Scan Interval	1 second							
Point Class	External							
Global Level	Local (for not sharing the point information with other controllers)							
Alarm Priority	None							
Message Priority	None							
Engineering Unit	Select a number that corresponds to the line number of “°F” for temperature and “GPM” for flow rate in Engineering Units Table							
Conversion Equation	Linear							
A/D Converter	Upper:12 bit Lower:16 bit	12 bit + 1 sign bit	12 bit	12 bit	12 bit	12 bit	Not Recommended Use PCU 7716	

Conversion Coefficient	Use Pop-up Calculator to calculate for slope and offset
Pop-up Calculator	Equipment Count Low: 0 (typical) Equipment Count High: depends on controller A/D converter, 255 for 8-bit, 4,095 for 12-bit and 65,535 for 16-bit Engineering Unit Low: The units being measured for the sensor when the device is at its low count value Engineering Unit High: The units being measured for the sensor when the device is at its high count value
Offset	0 (default) or actual error divide by "slope (m)"to calibrate sensor, compensate for the long wire runs
Low Sensor Limit	The lowest number showing sensor is not in error. This number is the lowest value of this point
High Sensor Limit	The highest number showing sensor is not in error. This number is the highest value of this point
Low Alarm Limit	The lowest number before this point goes into alarm
High Alarm Limit	The highest number before this point goes into alarm, at least equal to High Sensor Limit
Broadcast Change Counts	Round up number of 1% full scale divide by slope (m) For example: highest flow rate is 1000 GPM, Broadcast Change Counts = 0.01*1000/m
Non-linear Lookup Table	0 (no lookup table)

Repeat the above steps to set up analog input points for the flow meter and temperature sensors.

Step 2. Set-up internal analog output points in the EMCS to convert temperature from °F to °C.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".

b. Click "Add" and New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	AO
Output Address	Choose an un-reserved internal address (See Appendix A for the list of hardware point addresses to be avoided)
	Click "OK"
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 TempC for Building 1 Temperature in °C units
Scan Interval	60 seconds
Point Class	Internal
Global Level	Local (for not sharing the point information with other controllers)
Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of "C" for temperature in °C in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of "slope (m) = 0.1 and offset (b) = 0" in Conversion Coefficients Tables. If the correct slope and offset are not available, choose an empty pair (m=0, b=0) and enter the correct slope in the conversion coefficient editor (Edit -> Controller -> Station Parameters -> Conversion Coefficients)
Offset	0
Low Output Limit	0
High Output Limit	100
Broadcast Change Counts	1
	Click "OK"

Step 3. Create a Trend point extension on the first point setup in Step 2 to convert the temperature unit from °F to °C.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Point Extensions", then "Calculation".
b. Select the point name set-up in Step 2 from the list.
c. Click "Add" and Calculations editor will be displayed. Set the following parameters as specified below.

Equation	(P0-C0)*C1/C2
P0	Select the point of chilled/hot water temperature on the same side with an installed flow meter, analog input point created in Step 1
C0	32
C1	5
C2	9

Step 4. Set up an internal pulse input point in the EMCS for month-to-date thermal consumption.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".

b. Click "Add" and New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	PI
Input Address	See Appendix A on point address summary. Avoid using those hardware addresses.
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 BTU
Point Class	Internal
Scan Interval	1 second
Global Level	Local (for not sharing the point information with other controllers)
Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of "MBTU"in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of "slope (m) = 1 and offset (b) = 0" in Conversion Coefficients Tables
Conversion Equation	Linear
Accumulator Type	Integrating
Scans Between Broadcast	60 (broadcast value of this accumulator every 1 minute)
	Click "OK"

Step 5. Create a Trend point extension on the second point set-up in Step 4 to calculate the instantaneous thermal consumption.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Point Extensions”, then “Calculation”.
b. Select the point name set-up in Step 4 from the list.
c. Click “Add”, and Calculations editor will be displayed.

Set the following parameters as specified below:

Equation	C0*P0*(P1-P2)*(C1+C2*P3-(C3*(P3^C4))+(C5*(P3^C6))-(C7*(P3^C8)))
P0	chilled/hot water flow rate point
P1	chilled/hot water return temperature point
P2	chilled/hot water supply temperature point
P3	chilled/hot water temperature on the same side with an installed flow meter (unit in °C), point created in Step 2
C0	8.02486 for chilled water system or 8.01283 for hot water system
C1	999.8395
C2	0.06798
C3	0.00911
C4	2
C5	0.0001
C6	3
C7	1.127e-6
C8	4

Step 6. Create a Trend point extension on internal analog output point in EMCS to record 15-minute consumption values.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".
b. Click the "TR" box at the top of the window.
c. Locate the internal PI point displaying the current consumption (BLDG1 BTU in this example) and click on the point address.
d. Click "Add" and Trend Extension Editor will be displayed

Set the following parameters as specified below:

Sample Control Interval	15 minutes
Number of samples	1440 (will keep a fifteen-day rolling history of 15-minute demand readings in controller)
Sample control mode	None
	Leave all other items at their default value and click "OK."

Application E. Room Temperature Monitoring.

Charts E-1 through E-4 will take the user through steps to set up a temperature sensor to monitor room temperature. Following these steps will enable the EMCS to measure room temperature (°F) and store fifteen-minute data. Chart E-1 lists the needed equipment and helps the user determine whether the controller has an available input slot. Chart E-2 aids the user in choosing a temperature sensor. The chart lists each type of output with sensor accuracy for different controller models. The chart also lists wire and sensor specifications. Chart E-3 provides an example of a temperature sensor available in the market. Chart E-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to display current temperature and record 15-minute temperature. The user should then proceed to Application F to set up the data collection and history data storage.

STEP 1. Check the input slot availability on the controller.

Use Chart E-1 to find which slots are needed on the controller. The position of the slot can be found in Chart E-1 under Controller Terminal Connections. There are three types of acceptable temperature sensor inputs for most controllers: current, voltage and thermistor. Any of these inputs are acceptable depending on the application. For example, MR123 needs an available slot on TB3 for a thermistor temperature sensor. If there are no available slots please contact a TAC-Americas representative to check whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

STEP 2. Choose a Temperature Sensor.

Chart E-2 lists the temperature sensor specifications. For example, an acceptable temperature sensor for MR123 should have analog output with ±1°F accuracy or better. The end-to-end accuracy from the temperature sensor to the MR123 controller could be around ±2.5°F. Note that to gain this accuracy the temperature sensor must be placed no further than 200 ft. away with 22 AWG type wire. If this accuracy is not acceptable, a temperature sensor with better accuracy is needed or the controller needs to be replaced. Chart E-3 shows an example of a temperature sensor provided in the market.

STEP 3. Follow the EMCS programming steps.

Chart E-4 provides the steps to set up the external input point from the sensor that the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point.

STEP 4. Follow the steps in Application F.

Application F lists the steps to set up the data collection and history data storage.

After these steps are complete, the system will be able to display the current temperature and record 15-minute temperature data.

Chart E-1. Room Temperature Monitoring

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below. In addition, the terminal connections on the controller must have the resistors connected as specified below.

	7756 PCU	7700 DCU	7716 PCU 7718 PCU	7251 UC 7270 UC	7728 I/SITE I/O	7740 DCU	MR 55 MR 123	MR 88, 88R,160, 632
What is measured	• Room Temperature							
What is stored in EMCS	• Fifteen-minute data of room temperature in °F units stored in Trend Data History							
Needed	1 – Temperature sensor 1 – Available slot on Terminal Block (depends on output type of each device)							
Terminal Block for Current Analog Input	TB1-x, TB1A-x, TB1B-x, TB2-x, TB2A-x or TB2B-x where x can be 1, 4, 7 or 10	TB4–x or TB5-x	TB1 or TB2	TB1 or TB2 IN1 – IN8 (7251 UC) AI1 – AI8 (7270 UC)	TB1, TB2 or TB3	TB6-x or TB7-x	N/A	TB4
Terminal Block for Voltage Analog Input	0-10 V, upper motherboard TB1-x or TB2-x	TB4–x or TB5-x	TB1 or TB2	TB1 or TB2 IN1 – IN8 (7251 UC) AI1 – AI8 (7270 UC)	TB1, TB2 or TB3	TB6-x or TB7-x	TB4 (MR123)	TB4
Terminal Block for Thermistor Input	N/A	N/A	N/A	TB1 or TB2 IN1 – IN8 (7251 UC) AI1 – AI8 (7270 UC)	TB1, TB2 or TB3	N/A	TB3	TB3 or UI-x

	7756 PCU	7700 DCU	7716 PCU 7718 PCU	7251 UC 7270 UC	7728 I/SITE I/O	7740 DCU	MR 55 MR 123	MR 88, 88R,160, 632
Resistor in Terminal Block for Current Input	A 249Ω, 1/8W, 0.1% resistor in "A" position	None	A 249Ω, 1/8 W, 0.1% resistor in "A" position	With corresponding resistor in "B" position	A 249Ω, 1/8 W, 0.1% resistor in "A" position	None	N/A	A 249Ω, 1/8 W, 0.1% resistor in "A" position
Resistor in Terminal Block for Voltage Input	A 100KΩ, 1/8 W, 1% resistor in "C" position	None	A 100KΩ, 1/8 W, 1% resistor in "C" position		A 100KΩ, 1/8 W, 1% resistor in "C" position	None	None	A 249Ω, 1/8 W, 0.1% resistor in "A" position
Terminal Block for Thermistor Input	N/A	N/A	N/A		A 10KΩ, 1/8W, 1% resistor in "B" position	N/A	None	A 10KΩ, 1/8W, 0.1% resistor in "B" position

Chart E-2. Room Temperature Monitoring

Temperature Sensor Specifications

	7756 PCU	7700 DCU	7716 PCU 7718 PCU	7251 UC 7270 UC	7728 I/SITE I/O	7740 DCU	MR 55 MR 123	MR 88, 88R,160, 632
Output Type from Temperature Sensors	Analog, current, voltage or thermistor output							
Accuracy from Temperature sensor	Recommended accuracy for room temperature sensor ± 1.0 °F. This accuracy can be lower depending on the application used.							
End-to-end Accuracy for current output @ 75°F	Upper MB: ± 1.3 °F Lower MB: ± 1.09 %	±1.375 °F	±1.375 °F	±TBD °F	±1.375 °F	±1.375 °F	N/A	±2.5 °F
End-to-end Accuracy for voltage output @ 75°F	Upper MB: ± 1.075 °F Lower MB: ± 1.008 %	±1.075 °F	±1.075 °F		±1.075 °F	±1.075 °F	±2.5 °F (MR123)	±2.5 °F
End-to-end Accuracy for thermistor output @ 75°F	N/A	N/A	N/A		±2.5 °F	N/A	±2.5 °F	±2.5 °F
Maximum Wire Length (ft.)	200 ft. @ 22 AWG (guideline from manufacturer)							

Chart E-3. Room Temperature Monitoring

Example of Temperature Sensor Specification

Temperature Sensor, Vaisala, HMD 60 Y, Duct Temperature Transmitter		
Input	Temperature Range	-20 to 80 °C
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.6 °C over the span
	Linearity	± 0.1 °C or better

Chart E-4. Room Temperature Monitoring

EMCS Programming Steps

Summary

1. Set-up an external analog input point in the EMCS.
2. Create a Trend point extension on an external analog input point in EMCS to record 15-minute temperature values.

Details of these steps follow.

Step 1. Setup an external analog input point in the EMCS.

In I/NET 2000, perform the following steps:

a. Connect the installed sensors to the controller.

b. Select “Edit”, then “Controller”, then “Resident I/O Points”.

c. Click “Add” and New Resident Point editor will be displayed. Set the following parameters as specified below:

	7756 PCU	7700 DCU	7716 PCU 7718 PCU	7251 UC 7270 UC	7728 I/SITE I/O	7740 DCU	MR 55 MR 123	MR 88, 88R,160, 632
Input Type	AI							
Input Address	See Appendix A	TB4-x: 0X00 X = x –1 TB5-y: YY00 YY = y + 7 Ex: TB5-1 has the address of 0800 Point: 08 Bit Offset:00	0000-0007	SSPP00 – SSPP07	0000-0007 and 0100-0103	TB6-x: 0X00 X = (x –1)/2 TB7-y: YY00 YY = 8 + (y-1)/2 Ex: TB7-1 has the address of 0800 Point: 08 Bit Offset:00	00-03 (MR 55) 00,01 or 07 (MR 123)	00-06 except for MR632 00-04
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 Rm1 Temp							
Scan Interval	30 second							
Point Class	External							
Global Level	Local (for not sharing the point information with other controllers)							
Alarm Priority	None							
Message Priority	None							
Engineering Unit	Select a number that corresponds to the line number of “°F” in Engineering Units Table							

	7756 PCU	7700 DCU	7716 PCU 7718 PCU	7251 UC 7270 UC	7728 I/SITE I/O	7740 DCU	MR 55 MR 123	MR 88, 88R,160, 632
Conversion Equation	Linear							
A/D Converter	Upper:12 bit Lower:16 bit	12 bit + 1 sign bit	12 bit	8 bit	12 bit	12 bit	8 bit	8 bit
Conversion Coefficient	Use Pop-up Calculator to calculate for slope and offset							
Pop-up Calculator	• Equipment Count Low: 0 (typical) • Equipment Count High: depend on controller A/D converter, 255 for 8-bit, 4,095 for 12-bit and 65,535 for 16-bit • Engineering Unit Low: The units being measured for the sensor when the device is at its low count value • Engineering Unit High: The units being measured for the sensor when the device is at its high count value							
Offset	0 (default) or actual error divide by “slope (m)”to calibrate sensor, compensate for the long wire runs							
Low Sensor Limit	The lowest number showing sensor is not in error. This number is the lowest temperature.							
High Sensor Limit	The highest number showing sensor is not in error. This number is the highest temperature.							
Low Alarm Limit	The lowest number before this point goes into alarm							
High Alarm Limit	The highest number before this point goes into alarm, at least equal to High Sensor Limit							
Broadcast Change Counts	Round-up number of 5% full scale divide by slope (m) For example: temperature range is 40-100 °F, Broadcast Change Counts = 0.05*60/m							
Non-linear Lookup Table	0 (no lookup table), except for thermistor (consult with TAC-America representative on how to set-up this lookup table							
	Click “OK”							

Step 2. Create a Trend point extension on an external analog input point in EMCS to record 15-minute temperature values.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".
b. Click the "TR" box at the top of the window.
c. Locate the internal AI point displaying the room temperature (BLDG1 Rm1 Temp in this example) and click on the point address.
d. Click "Add" and Trend Extension Editor will be displayed.

Set the following parameters as specified below:

Sample Control Interval	15 minutes
Number of samples	1440 (will keep a fifteen-day rolling history of 15-minute demand readings in controller)
Sample control mode	None
	Leave all other items at their default value and click "OK."

Application F. Data Collection Configuration and Storage In I/NET 2000

Data collection in I/Net is a two-part process. First, the Trend Sampling point extension collects data in the controller memory and directs it to a specific cell on the host workstation. Then, Docutrend Cells provide storage locations on the host computer for data generated by the Trend Sampling point extension. The available space reserved on the host computer's hard drive decreases every time new data is stored in the host workstation. When all the space reserved for a given cell is used, the new incoming data will not be saved. To prevent data loss, Docutrend Cells must be archived periodically. Archived data can still be viewed and exported along with the most current data.

STEP 1. Configuring Host Computer Docutrend Masking.

Follow the step below to configure the host computer to perform Docutrend masking. I/Net utilizes "Message Masking" to manage network traffic. To ensure that the host computer stores Docutrend messages as intended, the Docutrend Masking on the host computer must match the masking on the point generating the data.

In I/NET 2000, perform the following steps:
Select "Edit", then "Host Computer", then "Configuration".
Host Configuration editor will be displayed. Check the appropriate boxes in the "Docutrend Cell" section. The simplest approach in most cases is to check all boxes in all four groups to ensure that the host receives all Docutrend data. Note even in this case, however, the data will be discarded if the Docutrend cell to which it is addressed does not exist.

STEP 2. Defining Docutrend Cell.

Use Chart F-1 to define memory cells in a host workstation. Data collected from a controller will be stored in these locations (cells).

STEP 3. Adding Trend Sampling.

Use Chart F-2 to set the parameters to collect the point data. The Trend Sampling point extension parameters determine how often a sample value is stored, the total number of samples stored in the controller, and the number of samples collected before the data is sent to the Docutrend Cell in the host computer. Data is stored in the host computer at a specified cell, a block of hard disk drive storage space reserved for I/Net data storage.

STEP 4. Archiving Docutrend Data.

Follow the steps below to save on-line Docutrend data to an archive file preventing data loss resulting when the RWONLN file size reaches its maximum capacity.

a. Select "Edit", then "Host Computer", then "Docutrend Cell Inquiry/Edit", then "Archive Data".
b. Highlight a cell in the cell list.
c. Set the latest date and latest time as desired.
d. Choose "New Archive".
e. Select "Archive All".
f. Insert the disk and select "OK".

It is recommended to archive the data at least once a month.

Chart F-1. Data Collection Configuration and Storage In I/NET 2000

Defining Docutrend Cell

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Host Computer”, then “Docutrend Cell Inquiry/Edit”, then “Cell Directory”.

b. Click “Add”, then enter a new cell number in Directory window.

c. Click “OK” and Cell Details Editor will be displayed. Set the following parameters as specified below.

Cell Name	Enter a name up to 16 characters in length
Cell Type	Analog (except the daily consumption and peak demand values generated by the Demand Control point extension. These values require a “Demand” cell type)
Transient duration (days)	45
	Click “OK”

Chart F-2. Data Collection Configuration and Storage In I/NET 2000

Adding Trend Sampling

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Point Extensions”, then “Trend Sampling”.

b. Locate the point to be trended and click on the point address.

c. Click “Add” and Trend Extension Editor will be displayed, Set the following parameters as specified below.

Distribution Group	Select one of the four numbers which corresponds to the distribution group defined in the host workstation where this data will be stored
Distribution Mask	Check masking box(es) to match those on the desired host computer workstation. If all boxes are checked in all groups on the Host computer, then checking any box in any group will log the data on that host.
Priority	Routine
Cell Number	Enter the corresponding number of cells as defined above
Cell Sample Count	4
Base Time	00:00
Interval (minutes)	15
Number of samples	200
Sample control mode	None
	Click “OK.”

APPENDICES

Appendix A: Reserved Point Addresses

Appendix B: Thermal Consumption Accuracy

Appendix A: Reserved Point Addresses

Table A.1 gives point address information for the various TAC-Americas controllers. Each point is assigned a ten-character point address composed of link, station, point, bit-offset numbers, and the two-letter point type. The point address is in the form LLSSPPBB PT, where LL designates the link, SS designates the station, PP designates the point, BB designates the bit offset, and PT designates the point type. The link and station numbers were assigned at the time of installation. Table A.1 lists the hardware point addresses for each point type. For example, the sensor installed in 7700 DCU, PI base unit slot 1, will be recognized as the hardware point 2800 PI. This table also reminds the user to avoid using these hardware points as a software or internal address points.

Table A.1 Controller Point Addresses

Controller	Hardware Point Addresses	
	Point or Board Type	Range (PPBB)
7700 DCU	DI / PI base unit	2800 –2807
	DI / PI expansion slot 3	2900 – 2907
	DI / PI expansion slot 2	3000 – 3007
	DI / PI expansion slot 1	3100 – 3107
	DO / PWM base unit	0000 – 1500
	DO / PWM expansion slot 1	1600 – 2300
	AI base unit	0000 – 1500
	AI expansion slot 4	1600 – 2700
	AO expansion slot 2	2400 –2700
	AO expansion slot 3	2800 – 3100
7716 PCU	Universal Input (UI) base unit	0000 – 0007
	DO base unit	0000 – 0007
	UI / DO expansion board: Inputs	0100 – 0107
	Outputs	0100 – 0107
	UI / AO expansion board: Inputs	0100 – 0107
	Outputs	3100 – 3103
	RTD expansion board	0100 – 0107
	AO expansion board	3100 – 3103
	Base HOA switch feedback	BB 08 & 09 on points 00-07
	Expansion HOA switch feedback	BB 08 & 09 on points 08-15
7718 PCU	Universal base unit	0000 – 0007
	DO / PWM base unit	0000 – 0007
	DO / PWM expansion board	0100 – 0107
	AI / DI / PI expansion board	0100 – 0107, 0200 – 0207
	AO base unit	3100 – 3107
	Base HOA switch feedback	BB 08 & 09 on points 00-07
	Expansion HOA switch feedback	BB 08 & 09 on points 08-15

Table A.1 (continued) Controller Point Addresses (continued)

Controller	Hardware Point Addresses	
	Point or Board Type	Range (PPBB)
7728 I/SITE	Universal Inputs	0000 – 0007, 0100 – 0103
	I/STAT	0104 – 0105
	Analog outputs	3100 – 3103
	Triac outputs	0000 – 0007, 0100 – 0101
	Auxiliary outputs	0102 – 0103
7740 DCU	DO / PWM base unit	0000 – 1500
	AI base unit	2800 – 2807
	DI / PI base unit	0000 - 0707
7756 PCU	DI / AI / PI upper motherboard	0000 – 0007
	DI / AI / PI lower I/O board	0100 – 0107, 0200 – 0207
		0300 – 0307
	DO / PWM upper motherboard	0000 – 0007
	DO / PWM lower I/O board	0100 – 0107
	AO lower I/O board	3100 – 3107
	HOA switch feedback upper motherboard	BB 08 & 09 on points 00-07
	HOA switch feedback lower I/O board	BB 08 & 09 on points 08-15
MR 55	DO / PWM	00 – 04
	DI / Thermistor	00 – 03
	CFM / LPS Transducer (MR55X only)	04
	I/STAT or Thermistor	07
MR88	Universal inputs	00 – 06
	DO (low voltage triac)	00 – 07
	I/STAT	07
MR88R	Universal inputs	00 – 06
	Form-C relay outputs	00 – 07
	I/STAT	07

Table A.1 (continued) Controller Point Addresses (continued)

Controller	Hardware Point Addresses	
	Point or Board Type	Range (PPBB)
MR123-032MB	AI DO (high voltage triac) DI AO I/STAT	00 – 01 00 – 02 02 – 04 03 – 04 07
MR123-210MB	AI DO (high voltage triac) DI DO (low voltage triac) I/STAT	00 – 01 00 02 – 04 03 – 04 07
MR123-210MB	AI DI DO (low voltage triac) I/STAT	00 – 01 02 – 04 03 – 06 07
MR123-430MB	AI DO (high voltage triac) DI DO (low voltage triac) I/STAT	00 – 01 00 – 02 02 – 04 03 – 06 07
MR160	Universal Inputs I/STAT	0000 – 0007, 0100 – 0106 0107
MR632	DO (low voltage triac) Universal Inputs AO I/STAT	00 – 02 00 – 04 03 – 04 07
7251 UC and 7270 UC	Universal Inputs Discrete outputs	00 – 07 00 – 07

Appendix B: Thermal Consumption Accuracy

The accuracy of thermal consumption depends on temperature sensor accuracy, flow meter accuracy, and the temperature difference as shown in the following tables. Each table represents the thermal consumption calculation accuracy based on a specific temperature difference, combinations of temperature sensor accuracy, and flow meter accuracy. For example, if a chilled water system has a temperature difference between the supply and return at 8 °F and we would prefer controlling the thermal consumption accuracy to be below 10%, we can select several combinations of temperature sensors and flow meter from the accuracy shown in Table B.2. We can choose a temperature sensor at 0.2 or 0.5°F accuracy with a flow meter of 0.5, 1 or 2% accuracy. For instance, 0.5°F accuracy temperature sensors and a 2% accuracy flow meter with an 8°F temperature difference yield 8.38% thermal consumption calculation accuracy. A better accuracy can be gained with a more accurate temperature sensor, a more accurate flow meter, or a higher difference in temperature. With the above example, the thermal consumption accuracy can be improved from 8.38% to 4.55% with 0.2°F temperature sensor replacement. Note that the above accuracy does not include the accuracy from the controller reading, signal loss along the wire, etc. That accuracy only takes the temperature sensor and flow meter into account.

Table B.1 Thermal accuracy calculation based on a 5 °F Temperature difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	4.52 %	10.55 %	20.60 %	40.70 %
1	5.04 %	11.10 %	21.20 %	41.40 %
2	6.08 %	12.20 %	22.40 %	42.80 %

Table B.2 Thermal accuracy calculation based on a 8 °F Temperature difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	3.01 %	6.78 %	13.06 %	25.63 %
1	3.53 %	7.31 %	13.63 %	26.25 %
2	4.55 %	8.38 %	14.75 %	27.5 %

Table B.3 Thermal accuracy calculation based on a 10 °F Temperature difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	2.51 %	5.53 %	10.55 %	20.60 %
1	3.02 %	6.05 %	11.10 %	21.20 %
2	4.04 %	7.10 %	12.20 %	22.40 %

Table B.4 Thermal accuracy calculation based on a 12 °F Temperature difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	2.18 %	4.69 %	8.88 %	17.25 %
1	2.68 %	5.21 %	9.42 %	17.83 %
2	3.70 %	6.25 %	10.50 %	19.00 %